

SECTION 27 31 17
PUBLIC ADDRESS SYSTEM

PART 1 – GENERAL

1.01 SECTION INCLUDES

- A. Functional requirements of PA system
- B. Performance requirements of PA system

1.02 RELATED SECTIONS

- A. Section 01 33 00, Submittal Procedures.
- B. Section 01 33 23, Shop Drawings, Product Data and Samples.
- C. Section 01 43 00, Quality Assurance.
- D. Section 01 45 00, Quality Control.
- E. Section 01 78 23, Operation and Maintenance Data.
- F. Section 01 78 39, Project Record Documents.
- G. Section 01 78 44, Spare Parts and Maintenance Materials.
- H. Section 01 79 00, Demonstration and Training.
- I. Section 20 50 13, Raceways for Facility Services.
- J. Section 20 70 19, Indoor Cabinets, Racks and Enclosures.
- K. Section 20 72 10, General Requirements for Systems Work.
- L. Section 20 72 15, General Requirements for System Design.
- M. Section 20 72 25, Factory and Field Testing.
- N. Section 20 80 00, Systems Integration Testing.
- O. Section 27 13 01, Communication Cables and Related Equipment.
- P. Section 27 30 01, Telephone Systems.

1.03 MEASUREMENT AND PAYMENT

- A. The work specified in this Section will be paid for under the applicable Bid Items based on the locations where work is performed, as identified in the Form –

Description of Bid Items, in accordance with Contract Specifications Section 01 20 00, Price and Payment Procedures.

1.04 REFERENCES

- A. Acoustical Society of America
 - 1. S1 Standards on Acoustics
 - 2. S2 Standards on Mechanical Vibration and Shock
 - 3. S12 Standards on Noise
- B. American National Standards Institute (ANSI)
 - 1. ANSI S1.1 Acoustical Terminology
 - 2. ANSI S1.4 Specifications for Acoustical Level Meters
 - 3. ANSI S1.8 Preferred Reference Quantities of Acoustical Levels
 - 4. ANSI S1.13 Methods for the Measurement of Sound Pressure Level in Air
 - 5. ANSI S3.2 Standard for Measuring the Intelligibility of Speech over Communication Systems
- C. Electronic Industries Association (EIA):
 - 1. RS-160 Sound Systems
 - 2. RS-174 Audio Transformers for Electronic Equipment
 - 3. RS-276 Acceptance Testing of Dynamic Loudspeakers
 - 4. RS-278 Mounting Dimensions for Loudspeakers
 - 5. RS-299 Loudspeakers, Dynamic, Magnetic Structures and Impedance
 - 6. RS-426 Loudspeakers Power Rating, Full Range
 - 7. RS-438 Test for Measuring Stiffness of Loudspeaker Spiders
 - 8. RS-446 Detail Specification - Illuminated and Non-Illuminated Pushbutton Switches
 - 9. SE-103 Speakers for Sound Equipment.
 - 10. SE-104 Engineering Specifications for Amplifiers for Sound Equipment.

- D. Institute of Electrical and Electronic Engineers, Inc. (IEEE):
 - 1. IEE 802.3af Power over Ethernet.
- E. California Occupational Safety and Health Standards (Cal OSHA)

1.05 ABBREVIATIONS

AC	Alternating Current
ACR	Auxiliary Communications Room
ADA	Americans with Disabilities Act
ALCU	Automatic Level Control Unit
BARTnet	BART Communications Network
DC	Direct Current
DSU	Destination Sign Unit
E and M	Ear and Mouth
FCP	Fire Command Post
ICS	Integrated Control System
ICMP	Internet Control Message Protocol
ICS	Integrated Computer System
IP	Internet Protocol
IPPBX	Internet Protocol Private Branch Exchange
LAN	Local Area Network
PoE	Power over Ethernet
PSTN	Public Switched Telephone Network
OCC	Operations Control Center
PA	Public Address
PLC	Programmable Logic Controller
SAB	Station Agent Booth
SCADA	Supervisory Control and Data Acquisition
SLPA	Signage, Lighting and Public Address
SNMP	Simple Network Monitoring Protocol

SPL	Sound Pressure Level
SRST	Survivable Remote Site Telephony
TCR	Train Control Room
UON	Unified Optical Network
UPS	Uninterruptible Power System
VMS	Variable Message Sign
VSS	Video Surveillance System

1.06 DESIGN WORK

- A. An acoustical modeling and test measurements shall be performed to verify conformance of the PA system design as indicated in ANSI S3.2 for intelligibility of speech and voice announcement requirements for a minimum Articulation Index of 0.80.
- B. The acoustic modeling study shall include recommended locations and number of additional speakers necessary for the PA system to achieve an average of 20 dBA of headroom above background ambient noise level plus or minus 3 dB at five feet above floor level in accordance with ANSI S1.8 and S1.13. Perform site survey of PA speaker locations to determine the background noise ambient sound pressure level (SPL). The background ambient noise level shall be used to calculate the nominal sound pressure level (SPL) in accordance with ANSI S1.13

1.07 SPEAKER LAYOUT GUIDELINES

- A. Speaker coverage shall include concourse areas, platform areas, men's and women's restrooms, staff rooms and the station agent booth. Coverage for platform areas shall extend for their full length.
- B. Where practical, speaker enclosures and supporting conduits in public areas shall be of a recessed design.
- C. Non-public areas shall have speaker enclosures located for efficient coverage without the need for high volume settings.
- D. Speaker enclosure placement shall be coordinated with the reflected ceiling, lighting, surveillance camera and signage designs.
- E. In public-areas, as a guideline, speakers shall be placed on 15 to 25-foot centers and arranged to give even coverage of all public areas with no objectionably high close-range spots. On the platform, speakers are mounted in the signage, lighting and PA (SLPA) raceway at 15 to 20-foot centers.
- F. Within enclosed areas, such as restrooms, break rooms and corridors, one speaker per 350 square feet or fraction thereof shall be provided. Speaker spacing may be adjusted to coordinate with station architectural features such as arched ceilings.

- G. Notwithstanding the specified spacing, the speakers shall be placed to meet the specified overall system performance.

1.08 SUBMITTALS

- A. Provide submittals in accordance with Contract Specifications Section 01 33 00, Submittal Procedures, Contract Specifications Section 01 33 23, Shop Drawings, Product Data and Samples, and Contract Specifications Section 01 78 44, Spare Parts and Maintenance Materials.
- B. Provide manufacturer's data sheets and descriptive information sufficient to determine compliance with these Specifications for the following:
 - 1. Complete functional diagram of the PA system.
 - 2. SPL coverage calculation, acoustical modeling and performance test results for the station platform and concourse levels. Coverage calculations shall be performed at five feet above platform, and concourse floor levels. Speaker outputs shall be at calculated SPL (refer to 1.06 B calculation) at four feet from speaker center line.
 - 3. Cabling, grounding, and shielding scheme in equipment cabinets.
 - 4. Description of the purpose and function of proposed test and diagnostic equipment, and procedures for programming the voice and tone synthesizer for pre-recorded messages.
- C. Provide detail drawings and technical data including list of equipment and material, including manufacturer's descriptive and technical literature, reliability performance charts and curves, catalog cuts, and installation instructions. Drawings shall show proposed layout and anchoring of equipment. System drawings shall show final configuration, including location, type and termination of inter-cabinet cables.
- D. Manufacturer's instructions: Where installation procedures, or any part thereof, are required to be in accordance with the recommendations of the manufacturer of the equipment being installed, submit printed copies of these recommendations for approval prior to installation. Submit operating instructions outlining the step-by-step procedures required for system operation including description of each subsystem in its operating mode. Instructions shall include the manufacturer's name, service manual, parts list, and brief description of equipment, components, and their basic operating features. Submit maintenance instructions listing regular maintenance procedures, possible system failures, a troubleshooting guide for repairs, and simplified diagrams for the system as installed.
- E. Factory and Field Test Plans and Reports: Submit factory and field test plans and reports in accordance with Contract Specifications Section 20 72 25, Factory and Field Testing, and Section 20 80 00, Systems Integration Testing.
- F. Operation and Maintenance Manuals: Submit O and M manuals in accordance with Contract Specifications Section 01 78 23, Operations and Maintenance Data.

- G. Training Materials: Submit training materials in accordance with Contract Specification Section 01 79 00, Demonstration and Training.
- H. Spare Parts List: Submit a recommended spare parts list in accordance with Contract Specifications Section 01 78 44, Spare Parts and Maintenance Materials.
- I. Record Drawings: Submit record drawings in accordance with Contract Specifications Section 01 78 39, Project Record Documents.

1.09 QUALITY ASSURANCE AND QUALITY CONTROL

- A. Refer to Contract Specifications Section 01 43 00, Quality Assurance and Section 01 45 00, Quality Control, for hardware quality assurance requirements and IEEE STD 730 for software quality assurance requirements.
- B. Products shall be manufactured by firms regularly engaged in manufacturing products described in this section.
- C. Field testing shall be performed by persons having five or more years of relevant testing experience.

1.10 FUNCTIONAL REQUIREMENTS

- A. The PA system design shall satisfy the following general requirements:
 - 1. All PA system equipment shall be powered from the 120 VAC Uninterruptible Power System (UPS).
 - 2. PA speakers shall be self-amplified and IP-addressable and shall be powered from PoE-enabled BARTnet access or edge switch.
 - 3. IP-speakers shall be monitored using (1) ICMP (Internet Control Message protocol) and (2), SNMP (Simple Network Monitoring Protocol) or an equivalent protocol.
 - 4. All PoE devices shall comply with the IEEE 802.3af standard for PoE.
 - 5. The PA system shall meet applicable provisions of the American with Disabilities Act (ADA).
- B. The station PA system shall interface to existing PA equipment at Central using the Unified Optical Network communications network for the following functions:
 - 1. Train arrival ADA announcements generated by the Integrated Computer System (ICS).
 - 2. Live messages and pre-recorded message requests from the Operations Control Center (OCC). A four-wire E & M to IP converter will be required to interface to the existing audio switch equipment in cabinet 43.

- C. Announcement Zones: The PA system shall be divided into two zones – platform and concourse; announcements shall be directed to these zones as follows:
 - 1. The IP telephone in the station agent booth (SAB) shall have the capability to announce to a single zone or both zones.
 - 2. Manual announcements made from any location other than those from the SAB shall be broadcast to both zones.
 - 3. Automatic messages shall be announced to both zones.
- D. Manual and Automatic Voice Announcements: The PA system shall be able to broadcast manual and automatic voice or tone announcements, as follows:
 - 1. Manual voice announcements shall be allowed through the IP telephone system using the IP telephone sets in the following locations:
 - a. SAB.
 - b. Platform areas with the exception of those at the end-of-platforms.
 - c. Fire command post (FCP) in the station.
 - d. Police room.
 - e. Central Control.
 - 2. Automatic voice and tone announcements shall be allowed from the following locations or subsystem:
 - a. fire alarm manual pull station, located on the concourse level of a station, shall upon activation, initiate a prerecorded voice message to be repeatedly sent over the PA system of the affected station. This announcement, in English and other foreign languages as may be required by the District, shall warn patrons that all station escalators will stop. Calculate the time to stop as the time it would take a patron who just stepped onto the longest escalator in the station to reach the next level. The calculated length of this announcement will be submitted to the District for approval if it does not comply with the Escalator BFS Specification Section 14 31 00, 2.09 “Controller and Wiring “ Section K.
 - b. In the event the station agent does not respond to an elevator service request, a one-time automatic service request announcement shall be made. This announcement shall be broadcast 90 seconds after a service request.
 - c. Unanswered phone calls or unsuppressed alarms at the SAB shall initiate a series of code calls in the form of chiming sounds. Chimes shall be initiated after 15 seconds of ringing for an unanswered call, instantly for call waiting, and 15 seconds of any alarm. The type of chimes shall be as follows:
 - 1) Courtesy phone call unanswered - two chimes
 - 2) IPPBX phone call unanswered - three chimes
 - 3) SAB SCADA system panel alarm unacknowledged - four chimes

- 4) Seismic activity detected – six chimes.
 - d. Once initiated, chimes shall repeat every 15 seconds until suppressed. Phone call chimes shall be suppressed from the SAB or by answering from any other station phone. Alarms shall be suppressed from the SAB SCADA system control panel.
 - e. The PA system shall send a signal to the ICS when the PA system is in use to synchronize announcement of train destinations with other announcements.
 - f. The destination sign system, in conjunction with its display unit and PA system, shall initiate automatic voice announcements of train arrival or train departure, as required.
- E. The IPPBX PA paging phone in the SAB shall allow selection of pre-recorded voice and tone messages for broadcast over the PA system. Messages can be one-time or continuous, with combined voice and tones.
- F. The destination sign system, in conjunction with its display unit and PA system, shall initiate automatic voice announcements of train arrival or train departure.
- G. The capability to display PA announcements on the destination sign units (DSUs) shall be provided but not implemented. This will require the use of real-time speech to text conversion.
- H. Announcement priorities, from highest to lowest, shall be as shown in Table 1. Any announcement with a priority of two or lower shall be pre-empted by an announcement of higher priority. Preempted automatic announcements shall resume after a higher priority announcement is completed.

TABLE 1 – PA ANNOUNCEMENT PRIORITIES

PRIORITY	SOURCE
1	FCP IPPBX phone
2	Fire alarm manual pull station
3	Code calls:
	• Seismic sensor
	• SAB annunciator panel alarm
	• Courtesy phone
	• IPPBX phone
4	Central Control (PA system activation and audio messages)
5	SAB IPPBX phone
6	Destination sign system
7	Platform IPPBX phones
8	Elevator service request.

- I. Digital volume controls shall be provided in the SAB, offices, conference rooms, and staff rooms to silence speakers in each respective location.

1.11 PERFORMANCE REQUIREMENTS

- A. The PA system shall be designed in accordance with EIA SE-104 and the following requirements:
 1. Frequency Response: Plus or minus three dB over the frequency range of 30 Hz to 20 kHz, and plus or minus one dB or better over the frequency range of 250 Hz to 5000 Hz as measured from the SAB handset to the output of any speaker.
 2. Total Harmonic Distortion (THD): Less than one percent over the frequency range of 30 Hz to 20 kHz measured at the output of any speaker.
 3. Operating Performance: Ambient temperature between 0 degrees C and 40 degrees C, and relative humidity of 5 percent to 95 percent.
 4. Headroom: Plus or minus 20 dB above nominal SPL, without increase in hum, noise, total harmonic distortion, or frequency response.
 5. Hum and Noise: 80 dB below nominal SPL.
 6. Power Capacity: 50 percent greater than power output at nominal SPL.
 7. Ambient Noise Compensation: A minimum of four microphones shall be employed for ambient noise compensation on the platform and concourse levels. This may be accomplished by using microphones inside selected speaker housings or external microphones. The ambient noise compensation subsystem shall comply with the following requirements:
 - a. Continuous adjustments from one second to five minutes for sampling of ambient noise conditions to provide a zero time delay for announcements.
 - b. Automatic adjustment range: 10 to 30 dB.
 - c. Sense channel: 250 Hz to 4 kHz +/- 1 dB.
 - d. Sense hold on announcement.

In addition to the above approach, volume level scheduling shall be deployed based on the average ambient noise profile for weekdays and weekend days.

1.12 INTERFACES WITH OTHER SYSTEMS

- A. The PA system server interfaces to the BARTnet access switch in the station TCR.
- B. The PA system server interfaces to the IPPBX telephone system; refer to Contract Specifications Section 27 30 01, Telephone Systems.

- C. The PA system interfaces to the survivable remote site telephony (SRST) router that provides connectivity to Central via the public switched telephone network (PSTN) in the event that the BARTnet service is unavailable. Refer to Contract Specifications Section 27 30 01, Telephone Systems.

PART 2 – PRODUCTS

2.01 SPEAKERS

- A. Speaker units shall include a factory assembled, double re-entrant type horn loudspeaker with an IP-addressable, printed circuit board (PCB) amplifier/control unit and a 15 watt compression driver mounted within a metal housing. Speaker units shall satisfy the following requirements:
1. Audio power handling capability - 15 watts.
 2. Frequency response - 600 to 14 kHz nominal.
 3. Average SPL level - 104 dB (1 W / 1 M average – 700 Hz to 5.5 kHz).
 4. Sound dispersion angle - 95 degrees.
 5. Speakers mounted within rooms shall employ an 18 gauge steel baffle. All other speakers shall employ a vandal-resistant, weatherproof housing with a cast aluminum alloy baffle and a perforated stainless steel grill.
 6. Loudspeakers in the end-of-line supervisor's booth, SAB, FCP, and offices shall be provided with digital volume controls to silence speakers in each respective location.
 7. Speakers shall be as manufactured by Atlas Sound or approved equal.
 8. Speakers installed outdoors exposed to the elements shall be weather resistant.
- B. The IP-addressable, PCB amplifier/control unit shall be mounted to the rear of the loudspeaker baffle. The amplifier/control PCB shall be capable of producing 9 watts RMS with a minimum of 9 VDC power provided via Cisco IEEE 802.3AF compliant PoE switches. All control functionality of the PCB amplifier shall be determined via software.
- C. A voice and tone synthesizer shall be provided to conform to the following requirements:
1. Messages: Minimum of thirty voice messages with a 30-second maximum time limit per message.
 2. Tones: Multi-frequency, constant or periodic.
 3. Supervision: Provision for supervision or fault detection in accordance with NFPA 72.

4. Quality: Messages generated shall be from recording and storage of human voices.
5. Message Storage: Messages shall be stored in solid-state memory devices.

2.02 ETHERNET I/O DEVICE SERVER

- A. The Ethernet I/O device server shall accept up to four contact closure inputs from SCADA and transmit status changes to the PA server via an Ethernet connection to the BARTnet access switch as shown. The Ethernet I/O device server shall be Perle Ethernet I/O device server model IOLAN DS1 D4 or approved equal.

2.03 PA SERVERS

- A. The PA servers for Central and the station TCR shall be PC-based workstations equipped with the specified accessories that meet or exceed the following requirements:
 1. Server Controller: The server controller shall be a 3.0 GHz Intel dual-core Pentium 4 processor or equal with 4 GB of RAM memory.
 2. Disk Storage: Disk storage shall include a 500 GB hard drive and an 8x max DVD optical drive.
 3. Monitor and Video card: One LCD flat panel display and a video card with 256 MB or more of memory. The monitor for Central shall be 22 inches, the monitor in the S20 ACR shall be 19 inches.
 4. Expansion Slots: Five PCI/PCI-E expansion slots.
 5. External Ports: (6) USB 2.0, (1) serial, (1) parallel, (2) PS/2, (1) RJ-45 integrated LAN.
 6. Keyboard and Mouse: One multifunction keyboard and a USB optical wheel mouse.
 7. Provide a tower to rack conversion kit for the server in the station TCR.
 8. System and Application Software: Provide the following operating system and application software:
 - a. Operating system – Windows Server 2008 or later.
 - b. Server application software: Singlewire Software ControlKom Enterprise or approved equal for the Central server; Singlewire Software ControlKom Classic or equal for the S20 server.
 - c. EtherNet I/O device server application software: Singlewire Software Direct Observation and Real-time Alerting (DORA) or equal.

2.04 4-WIRE E & M TO IP CONVERTER

- A. The 4-wire E & M to IP converter shall use a multiservice access concentrator to convert the existing 4-wire E and M circuit at Central to TCP/IP. The converter shall be Cornet Technology model IPGate 1000-16 or equal.

2.05 FIBER OPTIC AND CATEGORY 6 CABLES AND PATCH PANELS

- A. Fiber optic and Category 6 cables, patch panels and related accessories shall conform to the requirements of Contract Specifications Section 27 13 01, Communication Cables and Related Equipment.

2.06 STATION AGENT'S BOOTH EQUIPMENT

- A. The SAB shall be equipped with the following.
 - 1. An IPPBX PA paging phone providing the following functions:
 - a. Pushbuttons for zone announcements; one per zone, one for all-calls, and two for future zones. The pushbuttons shall latch and illuminate upon activation.
 - b. Pushbuttons for control functions; one pushbutton to unlatch, one push button to silence code calls, and two spares.
 - c. Pushbuttons and lamps conforming to 16 mm IEC style pushbuttons per NEMA Type 13 and EIA RS-446.
 - d. Push pad for the select panel to activate pre-recorded messages from the voice and tone synthesizer.
 - e. LED lamps and lamp test for pushbuttons.
 - f. PA busy lamp indicating zone activation.
 - 2. Loudspeaker: Mounted in the ceiling.
 - 3. Loudspeaker Volume Control: Adjustable from 60 dBA SPL.

2.07 PA EQUIPMENT CABINETS

- A. PA equipment cabinets shall conform to Contract Specifications Section 20 70 19, Indoor Cabinets, Racks, Frames and Enclosures.

PART 3 – EXECUTION

3.01 FACTORY TESTS

- A. Perform factory tests in accordance with the requirements specified in Contract Specifications Section 20 72 25, Factory and Field Testing, and the following requirements.

- B. The factory test demonstration shall include the following equipment as a minimum:
 - 1. A BARTnet PoE-enabled edge switch with six connected speakers.
 - 2. Two IPPBX phones.
 - 3. Both PA servers.
 - 4. The Ethernet I/O device server.
 - 5. One ambient noise microphone.

3.02 INSTALLATION

- A. Install PA speakers, cabinets, panels and associated raceways and cables in accordance with the Contract Drawings and Section 20 72 10, General Requirements for Systems Work. Cabling shall be installed in accordance with Contract Specifications Section 27 13 01, Communication Cables and Related Equipment.
- B. Install inter-cabinet connections identified on the Contract Drawings. All equipment shall be powered from the local 120 VAC essential power panel.
- C. Perform system configuration to provide proper communications between all PA system equipment, the BARTnet network and the existing PA console at Central.

3.03 SOFTWARE CONFIGURATION

- A. Follow the manufacturer's software configuration guides and the District's direction to configure the PA servers for Central and the stations and the EtherNet I/O device server.
- B. The District will establish requirements for all equipment IP addresses.

3.04 FIELD TESTS

- A. Comply with the requirements in EIA RS-276 - Acceptance Testing of Dynamic Loudspeakers and RS-490 - Standard Test Methods of Measurement for Audio Amplifiers. Conduct field tests in four phases following the installation of all PA speakers, cabinets, panels and associated raceways and cables.
- B. Phase 1 – Installation Verification: Verify the continuity and correct termination of all cabling using Contractor-prepared interconnection diagrams. Test all cabling in accordance with the requirements specified in Contract Specifications Section 27 13 01, Communication Cables and Related Equipment.
- C. Phase 2 – PA Coverage and Speech Intelligibility Testing: Test the coverage and intelligibility of voice announcements within the passenger station. Tests shall be conducted with announcements made locally from the SAB and other IPPBX phones with access to the PA system. The methods used for the measurement of SPLs and

intelligibility of speech and sound shall conform to the requirements of ANSI S1.13 - Methods for the Measurement of Sound Pressure Level in Air and S3.2 - Standard for Measuring the Intelligibility of Speech over Communication Systems. Verify system frequency response from handset to loudspeaker output at nominal SPL.

- D. Phase 3 – Inter-System Testing: Perform inter-system testing; e.g., PA-fire alarm-telephone-SCADA and PA-IPPBX systems to verify that signals are correctly transferred between each system.
- E. Phase 4 – Testing from Central: Verify connectivity to station and announcements from the Central PA console.

END OF SECTION 27 31 17